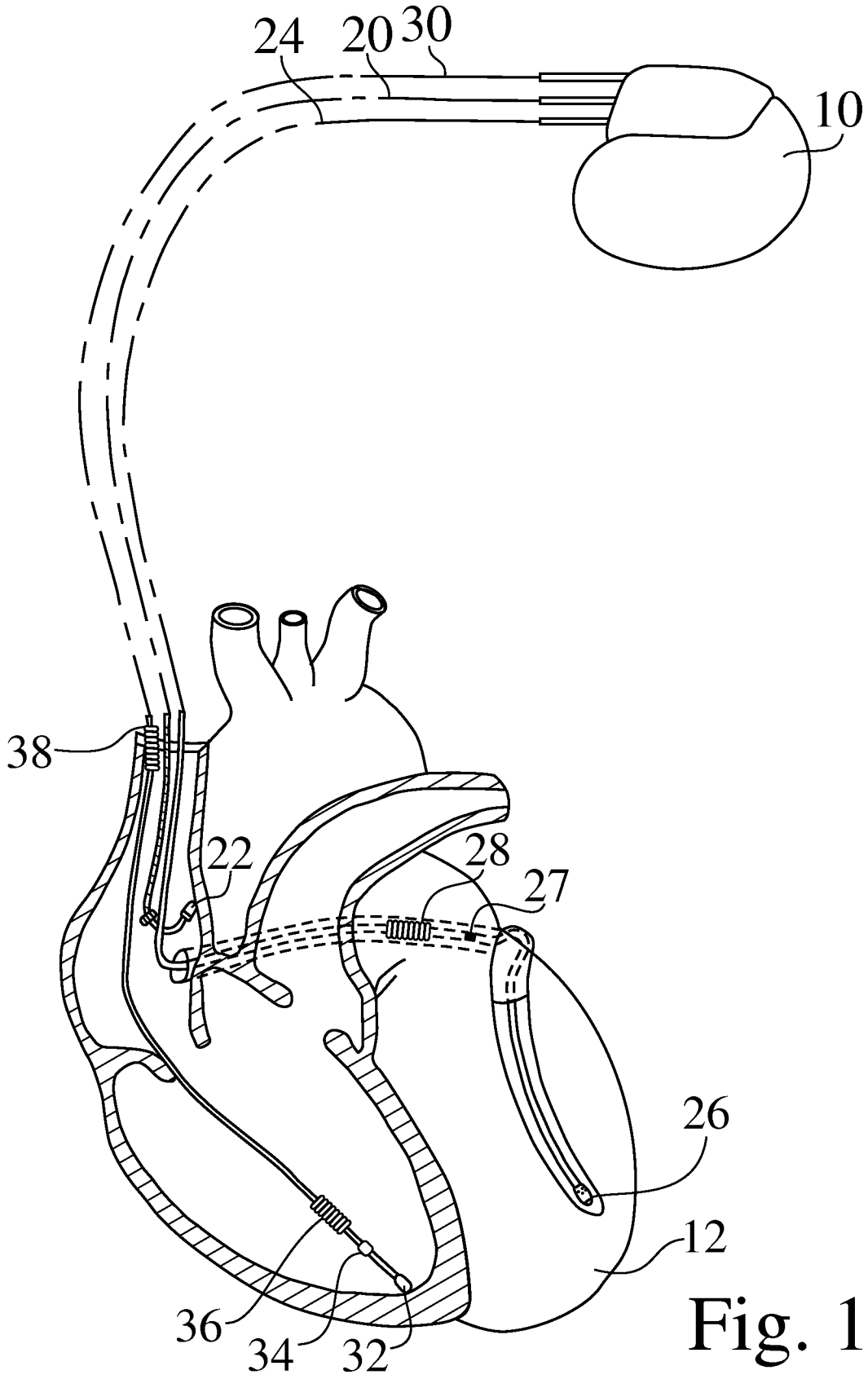

Fig. 1A

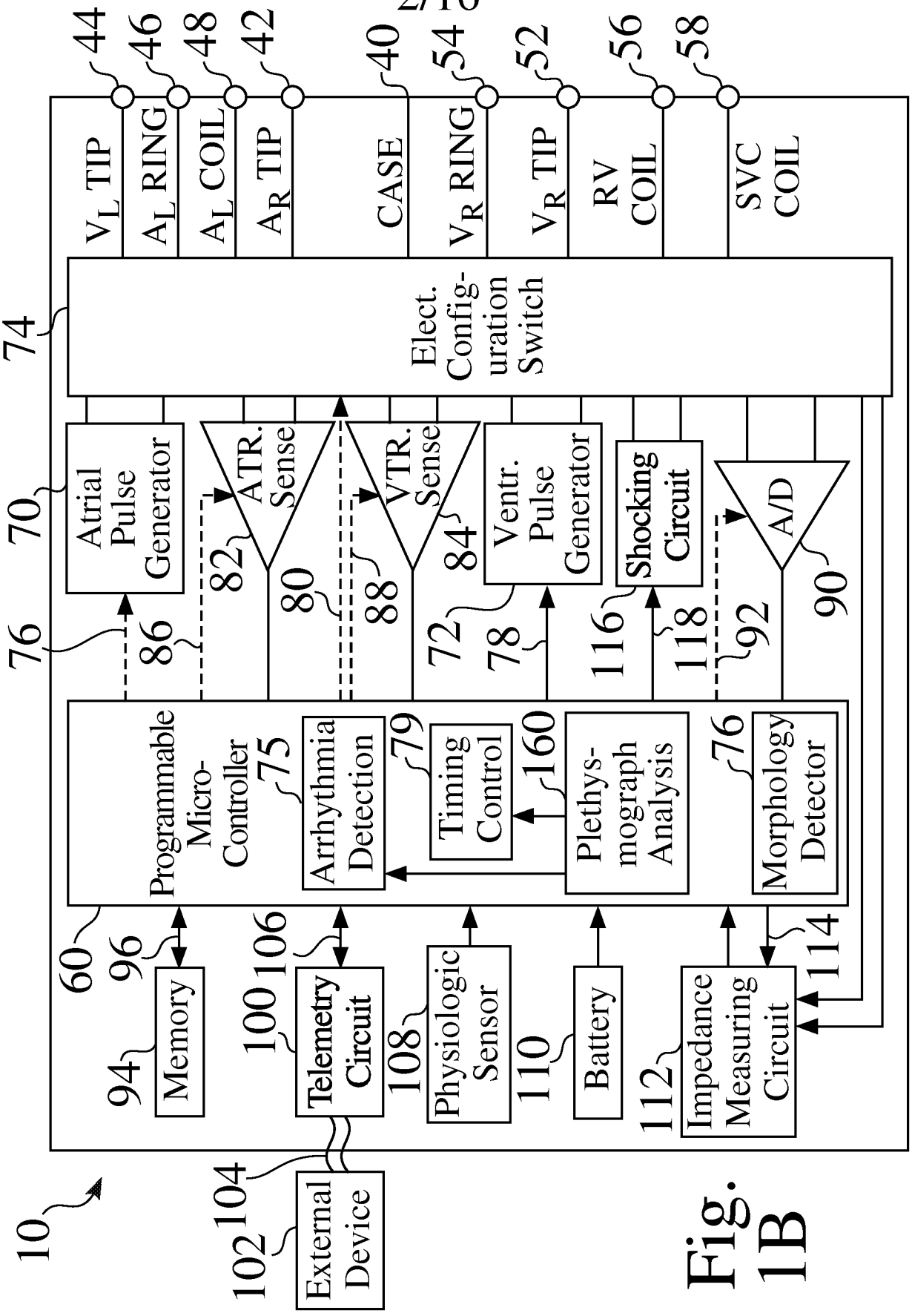
10
44
46
48
42
40
54
52
56
58
V_L TIP
A_L RING
A_L COIL
A_R TIP
CASE
V_R RING
V_R TIP
RV COIL
SVC COIL
74
Elect. Config-uration Switch
70
Atrial Pulse Generator
82
ATR. Sense
80
88
VTR. Sense
84
Ventr. Pulse Generator
Shocking Circuit
A/D
90
76
86
72
78
116
118
92
Programmable Micro-Controller
75
Arrhythmia Detection
79
Timing Control
160
Plethys-mograph Analysis
76
Morphology Detector
60
96
94
Memory
100
106
Telemetry Circuit
108
Physiologic Sensor
110
Battery
112
Impedance Measuring Circuit
114
102
104
External Device

Fig. 1B

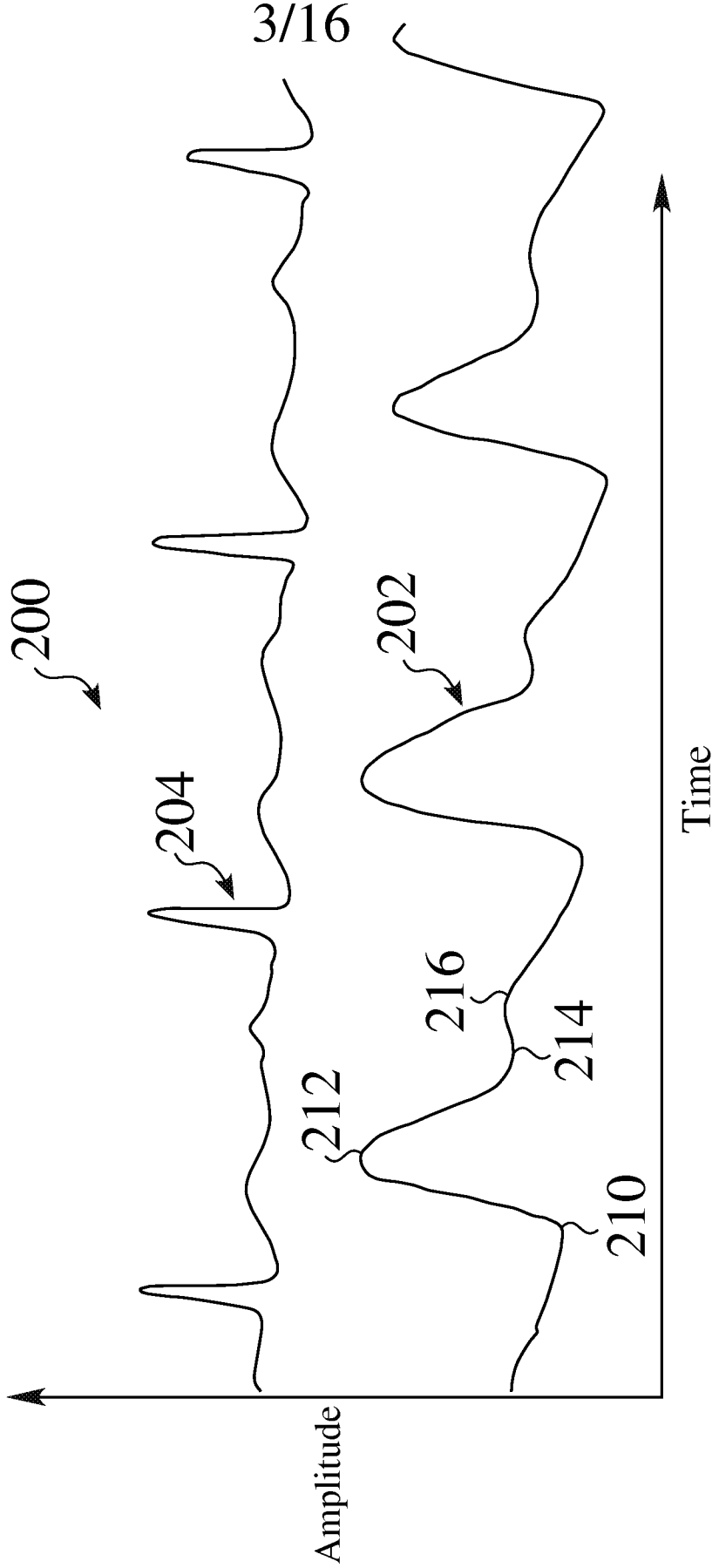

Fig. 2

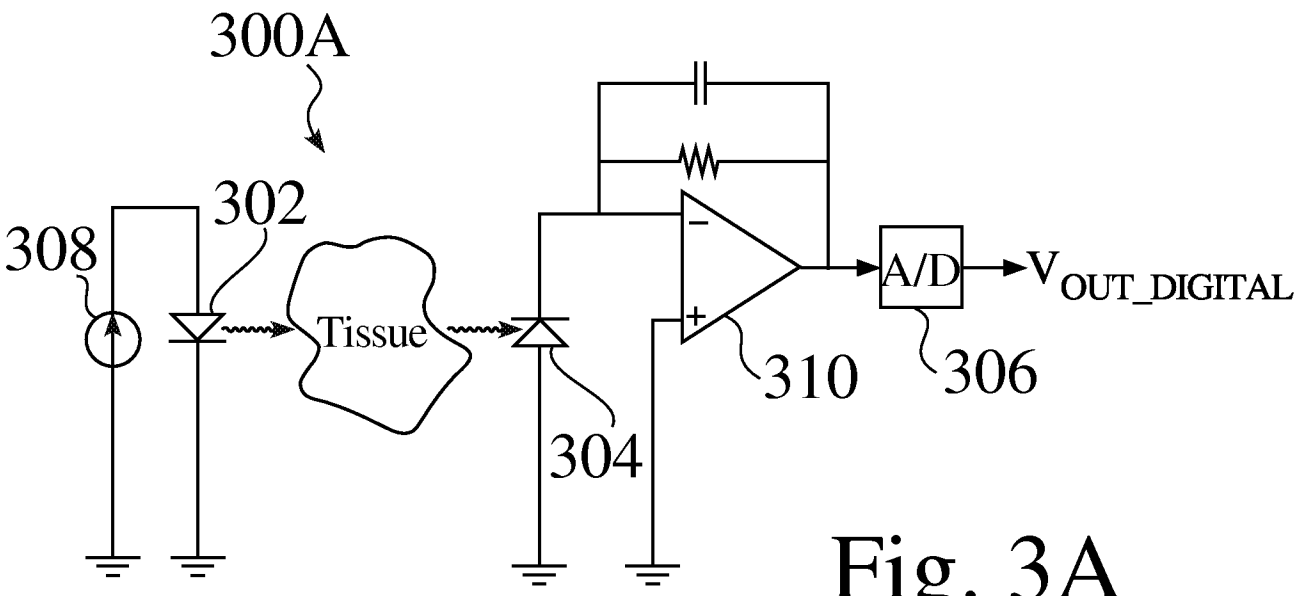

Fig. 3A

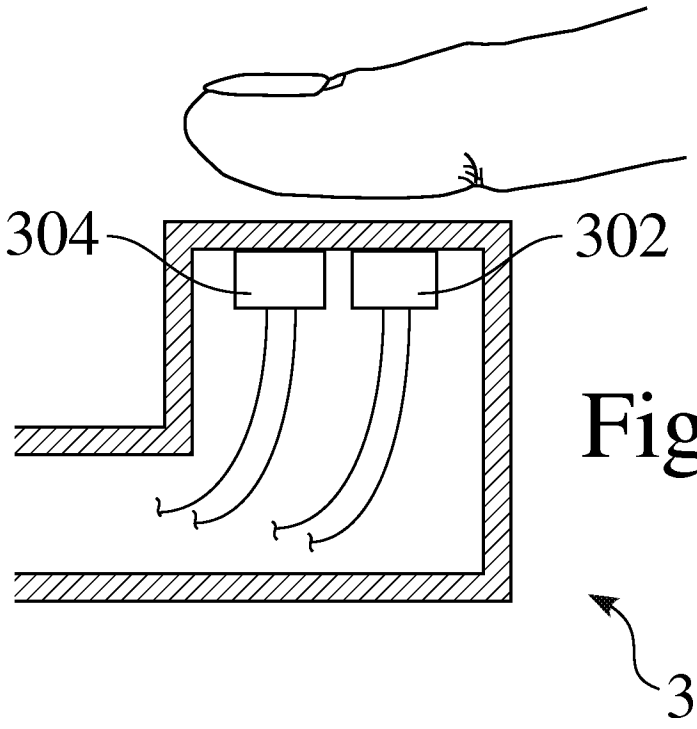

Fig. 3B

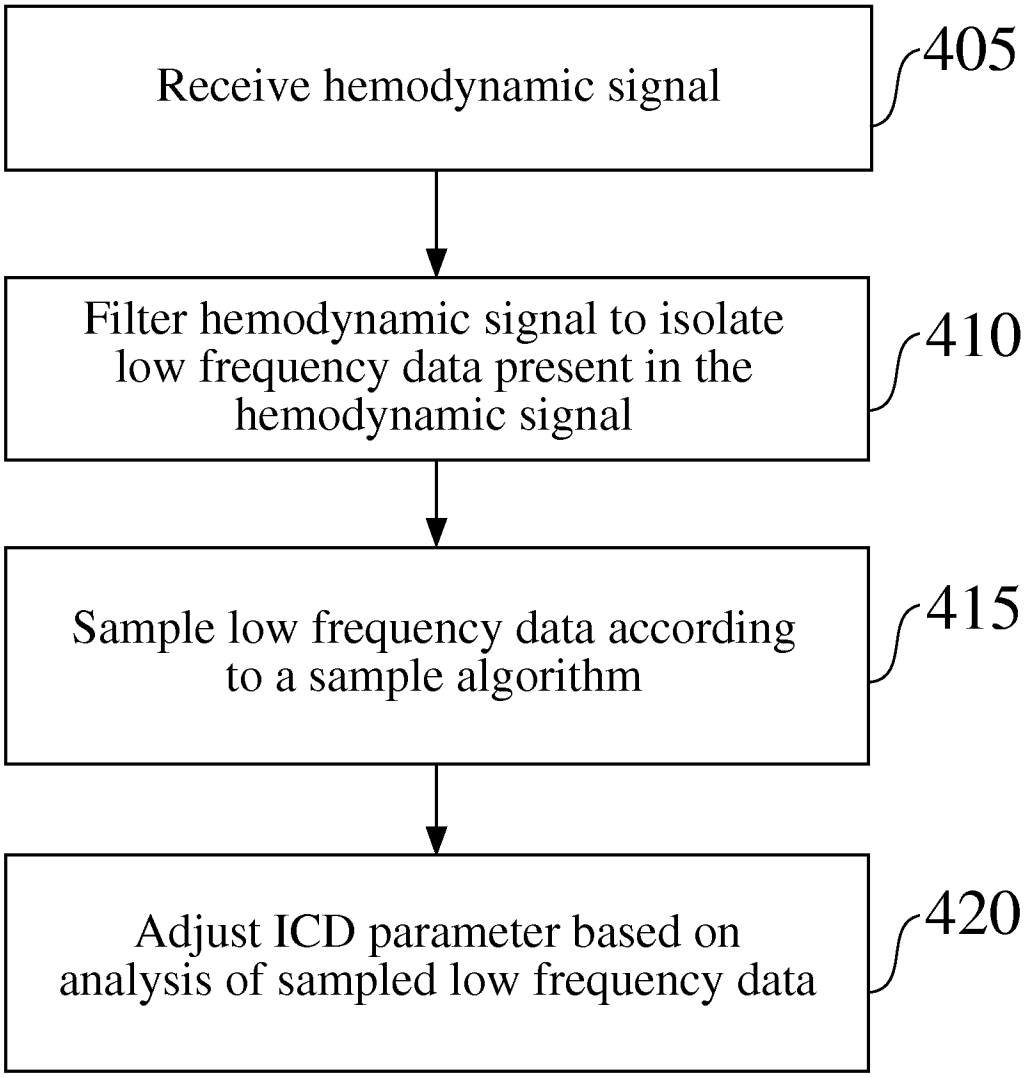
Receive hemodynamic signal
405
Filter hemodynamic signal to isolate low frequency data present in the hemodynamic signal
410
Sample low frequency data according to a sample algorithm
415
Adjust ICD parameter based on analysis of sampled low frequency data
420

Fig. 4

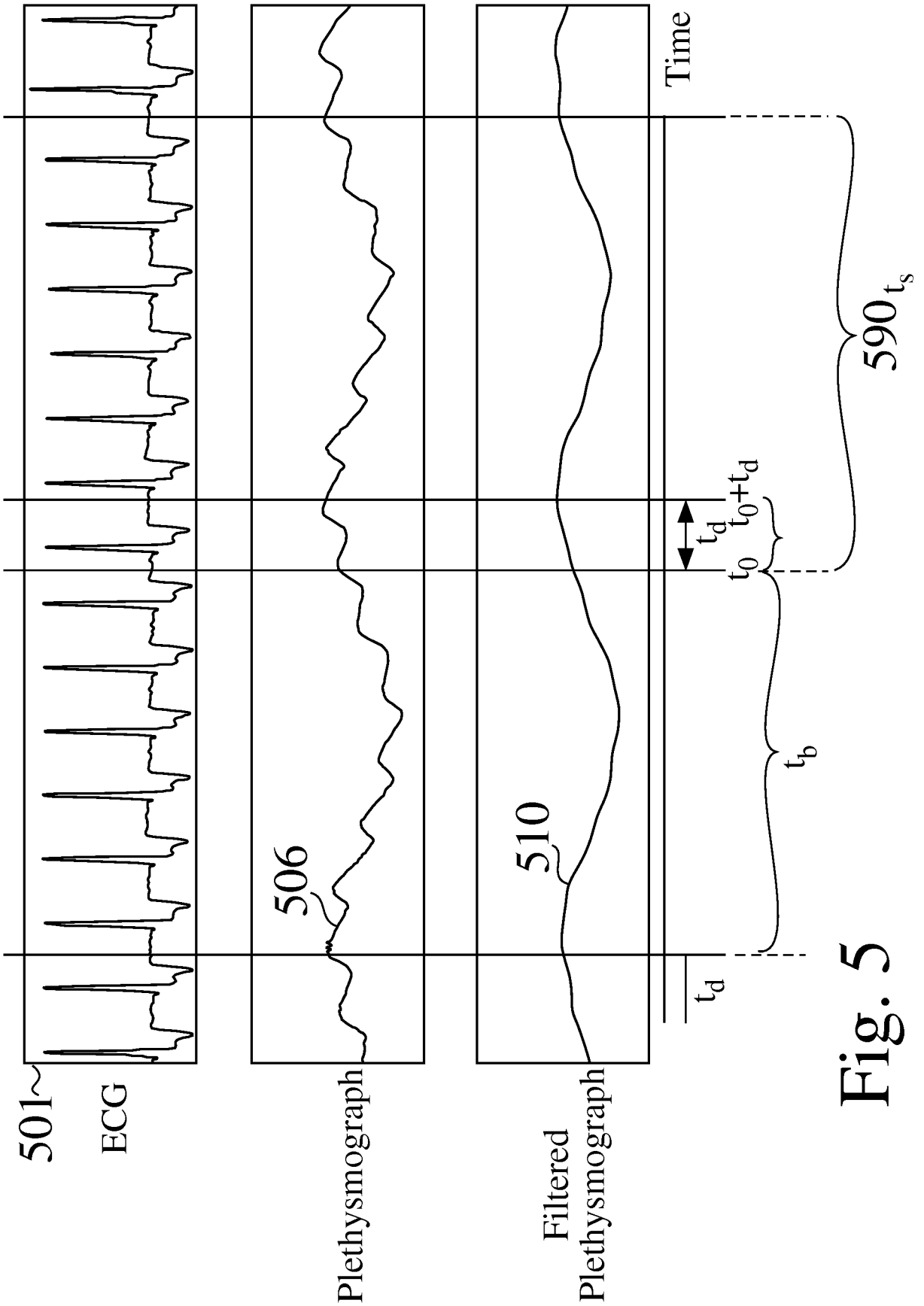
501
ECG
Plethysmograph
506
Filtered
Plethysmograph
510
Time
t_d
t_0
t_0+t_d
t_b
590
t_s

Fig. 5

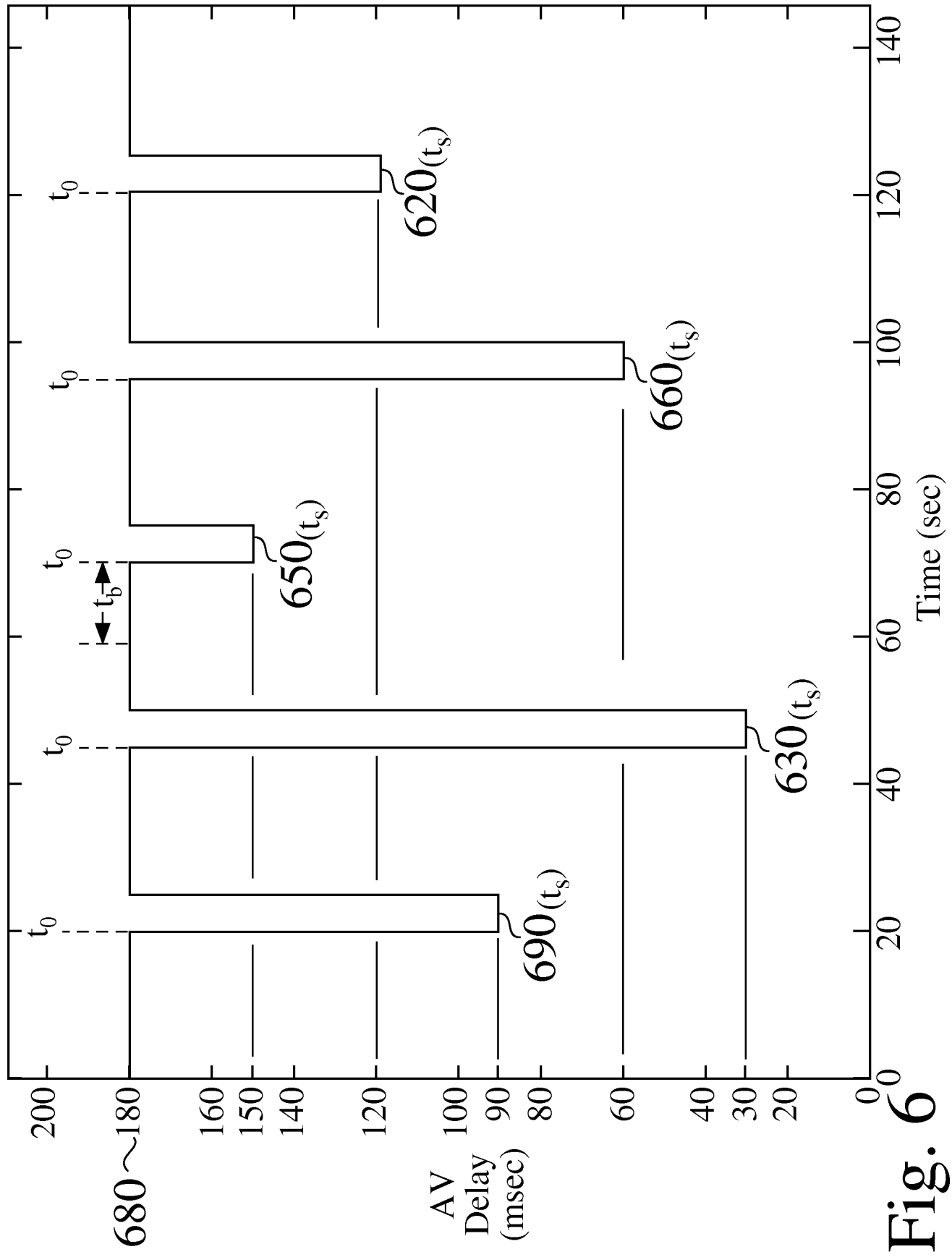
AV Delay (msec)
200
680~180
160
150
140
120
100
90
80
60
40
30
20
0
0
20
40
60
80
100
120
140
Time (sec)
t_0
t_0
t_0
t_0
t_0
t_b
$620_{(t_s)}$
$660_{(t_s)}$
$650_{(t_s)}$
$630_{(t_s)}$
$690_{(t_s)}$

Fig. 6

Sampling, Algorithm for AV-Delay Embodiment using Plethysmography

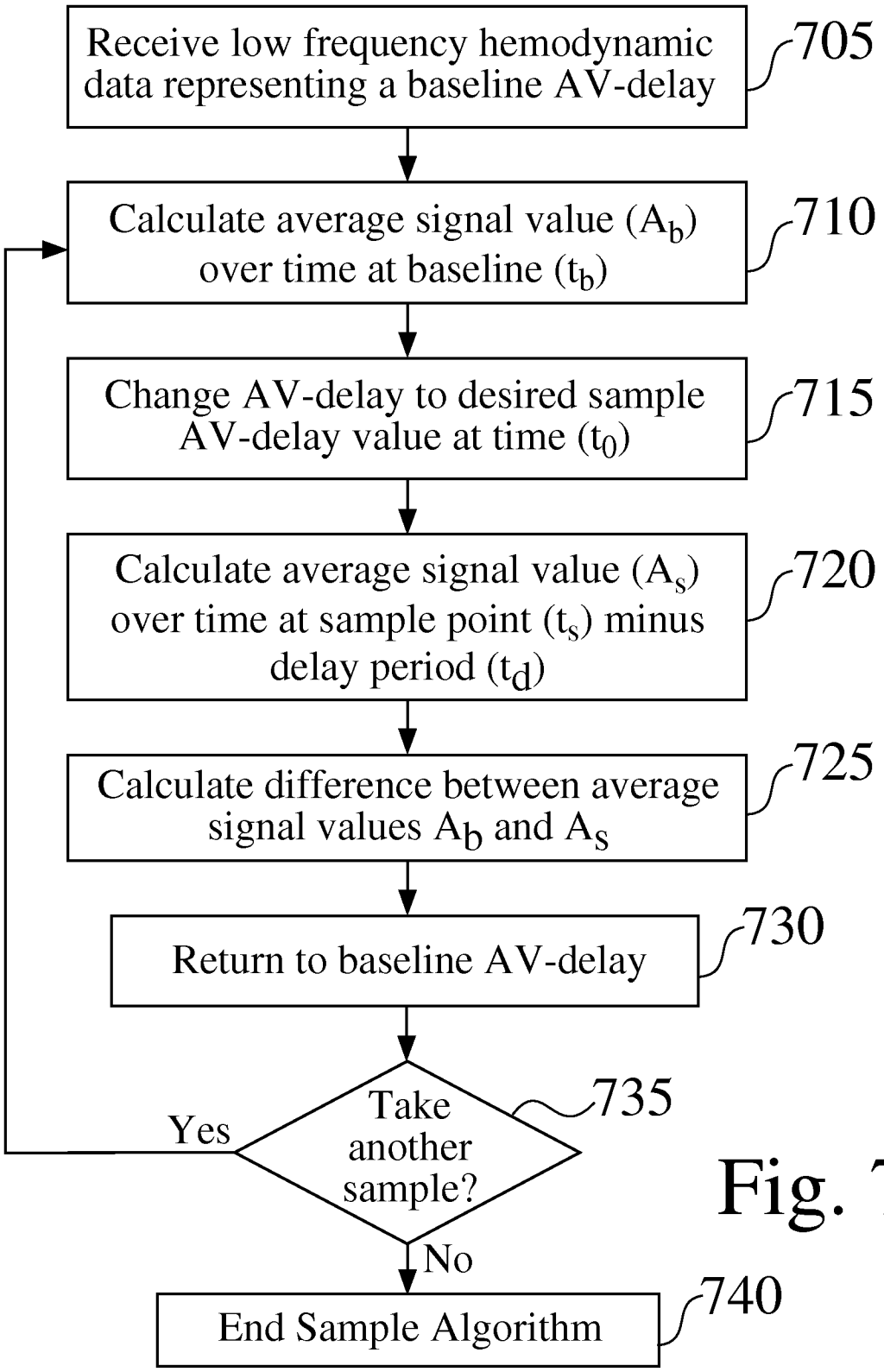

Fig. 7

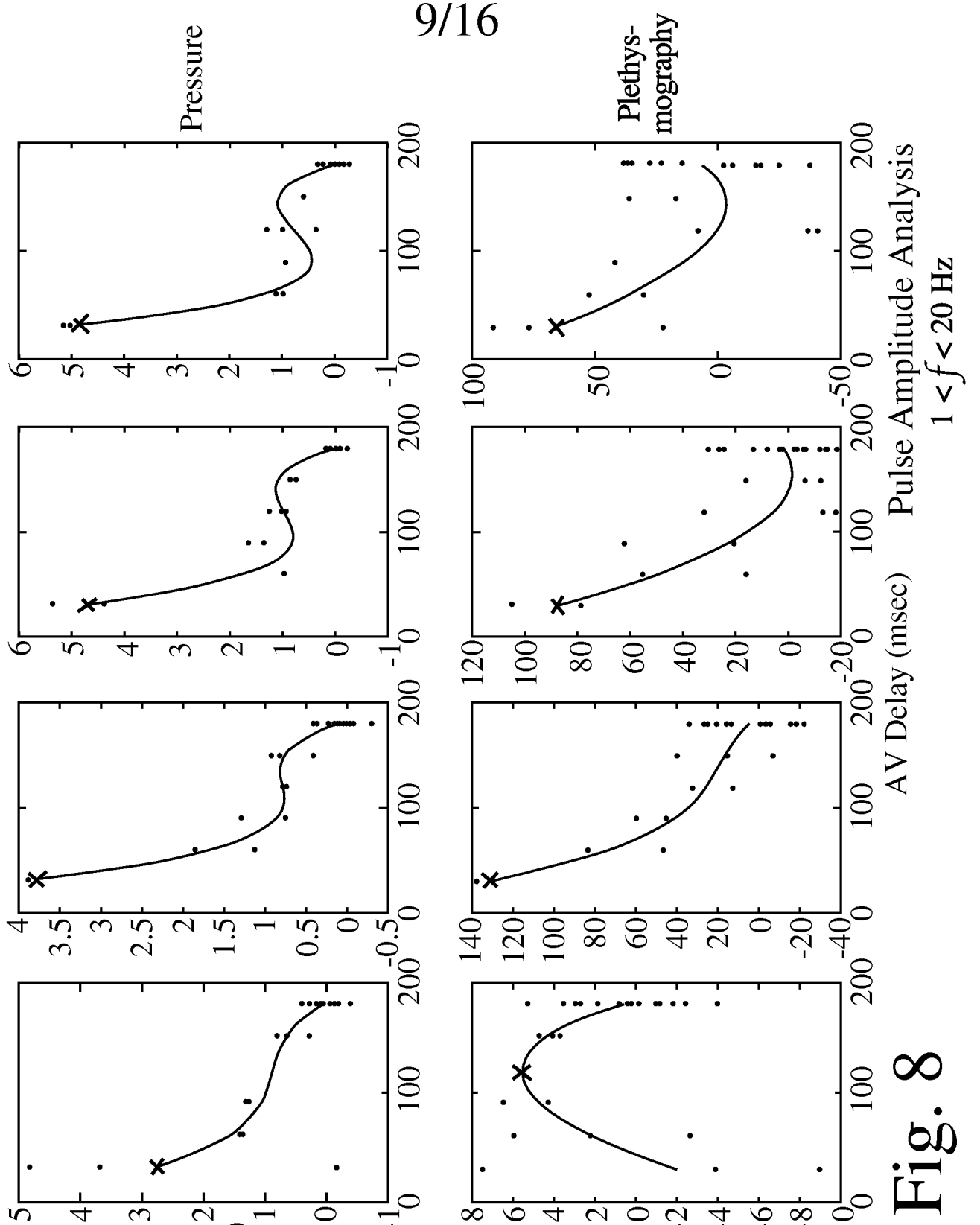
Pressure
Plethys-
mography
Change in Aortic BP (mmHg)
Decrease in Reflected Light (mvolt)
AV Delay (msec)
Pulse Amplitude Analysis
1 < f < 20 Hz

Fig. 8

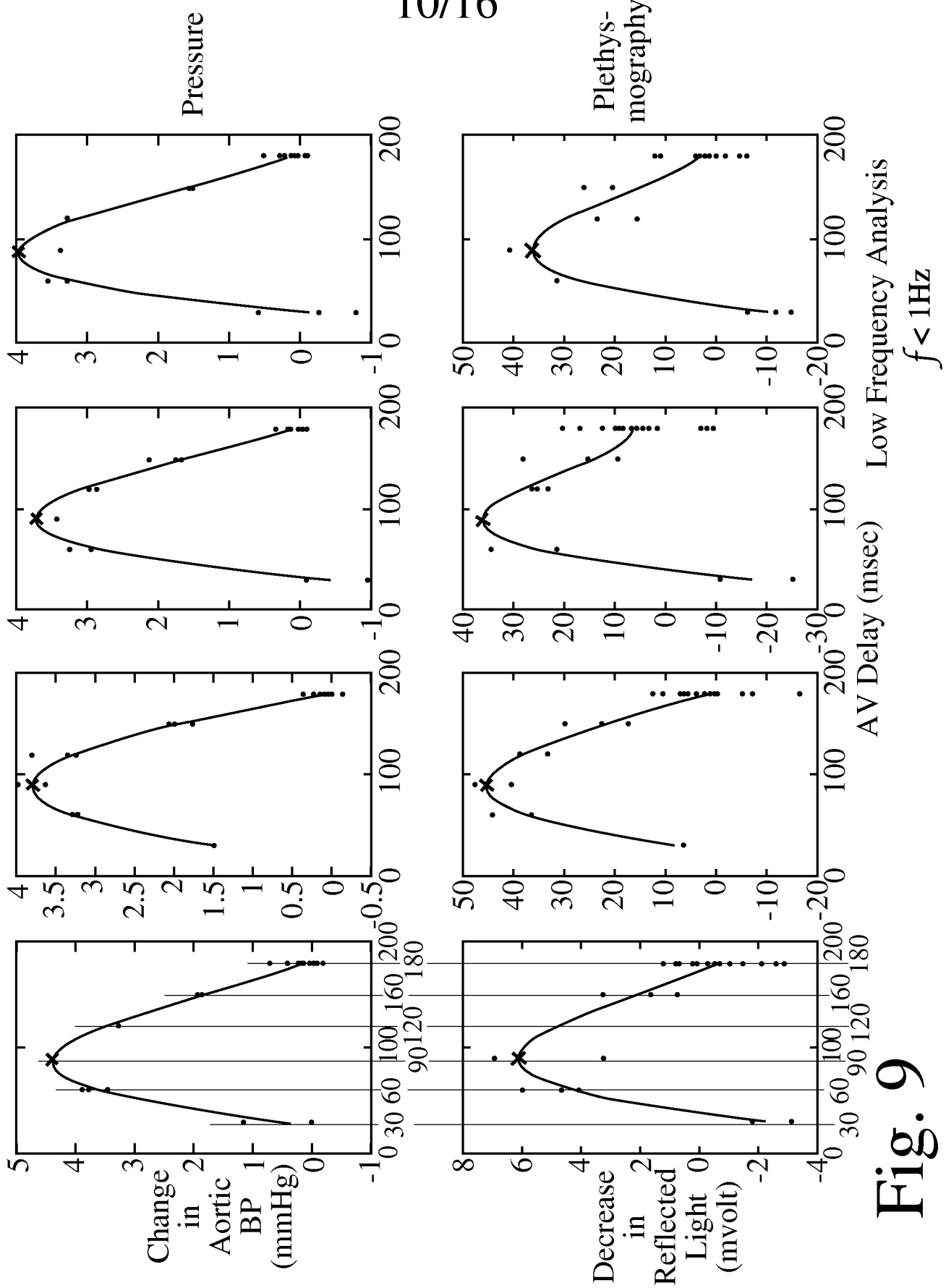
Pressure
Plethys-
mography
Change
in
Aortic
BP
(mmHg)
Decrease
in
Reflected
Light
(mvolt)
AV Delay (msec)
Low Frequency Analysis
f < 1Hz

Fig. 9

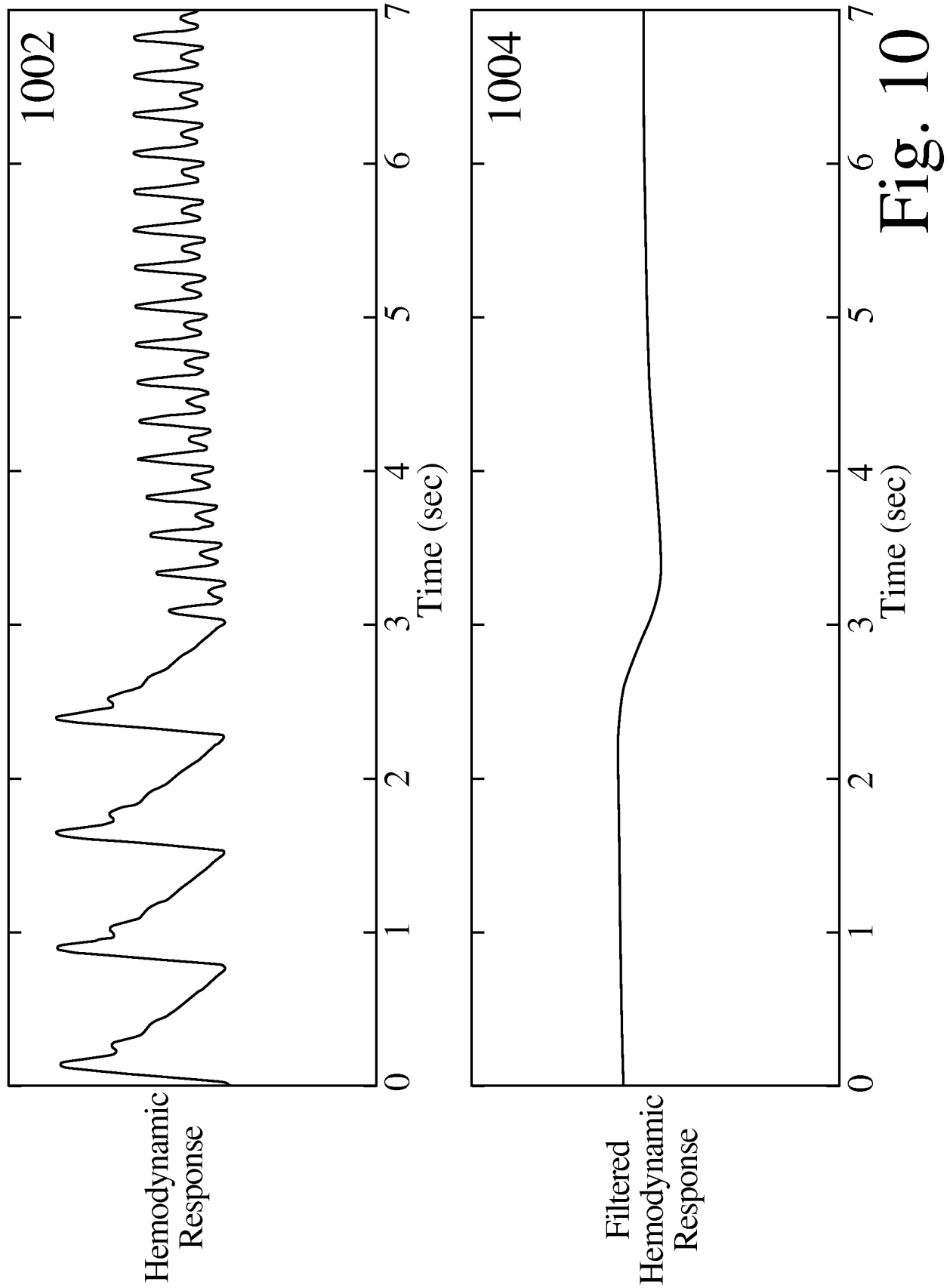
1002
Hemodynamic Response
0
1
2
3
4
5
6
7
Time (sec)
1004
Filtered Hemodynamic Response
0
1
2
3
4
5
6
7
Time (sec)

Fig. 10

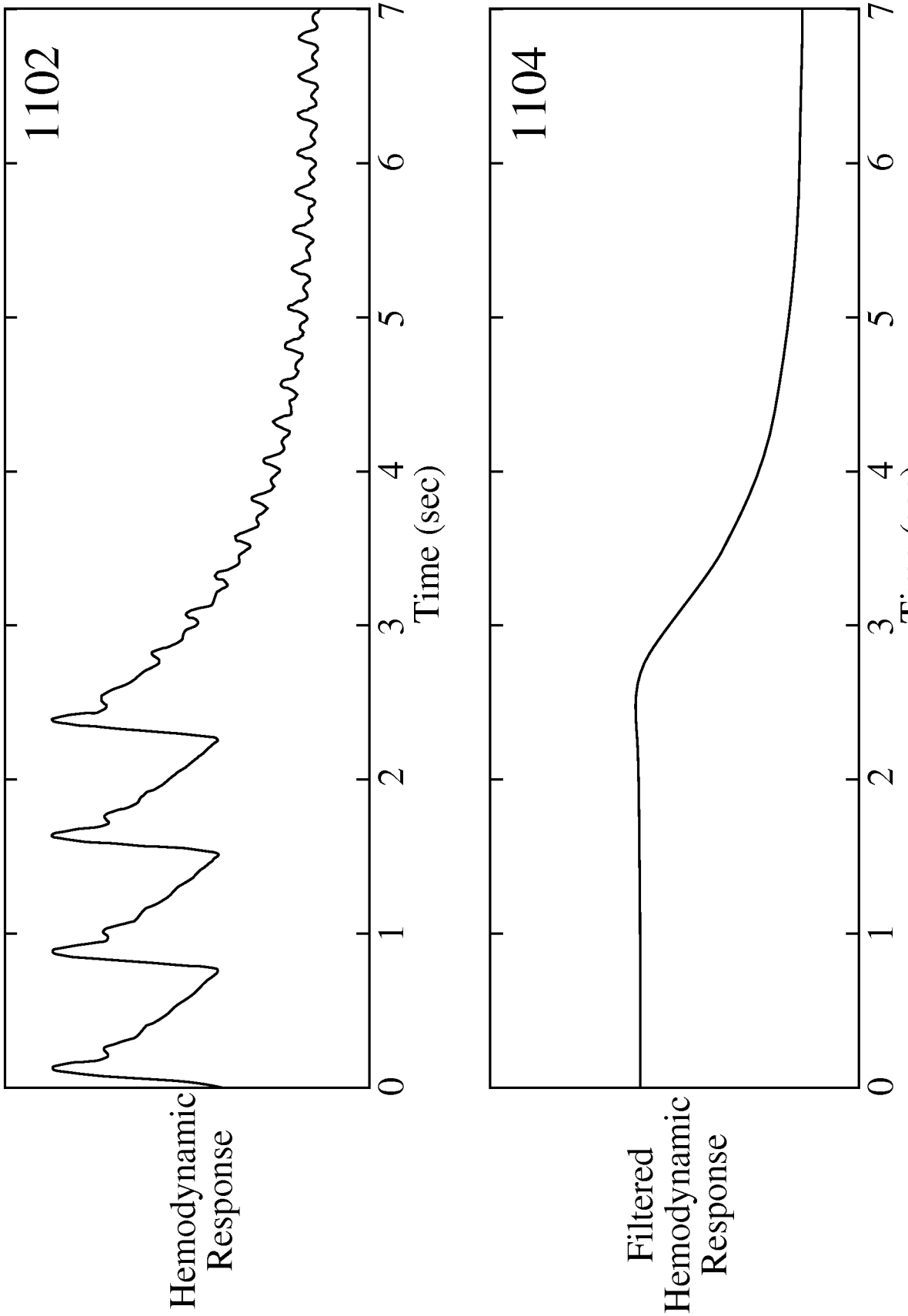
1102
Hemodynamic Response
0
1
2
3
4
5
6
7
Time (sec)
1104
Filtered Hemodynamic Response
0
1
2
3
4
5
6
7
Time (sec)

Fig. 11

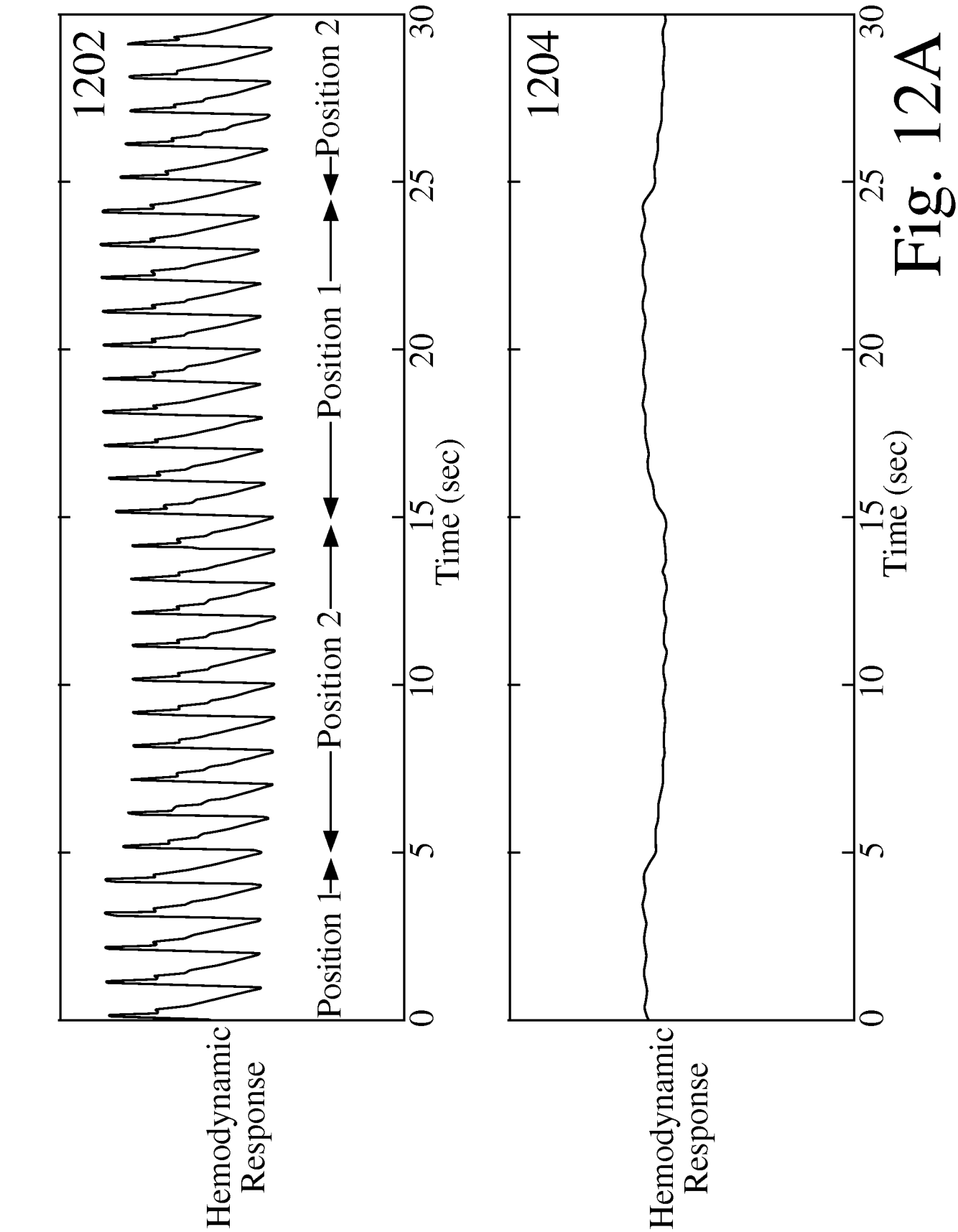
1202
Position 1
Position 2
Position 1
Position 2
Hemodynamic Response
0
5
10
15
20
25
30
Time (sec)
1204
Hemodynamic Response
0
5
10
15
20
25
30
Time (sec)

Fig. 12A

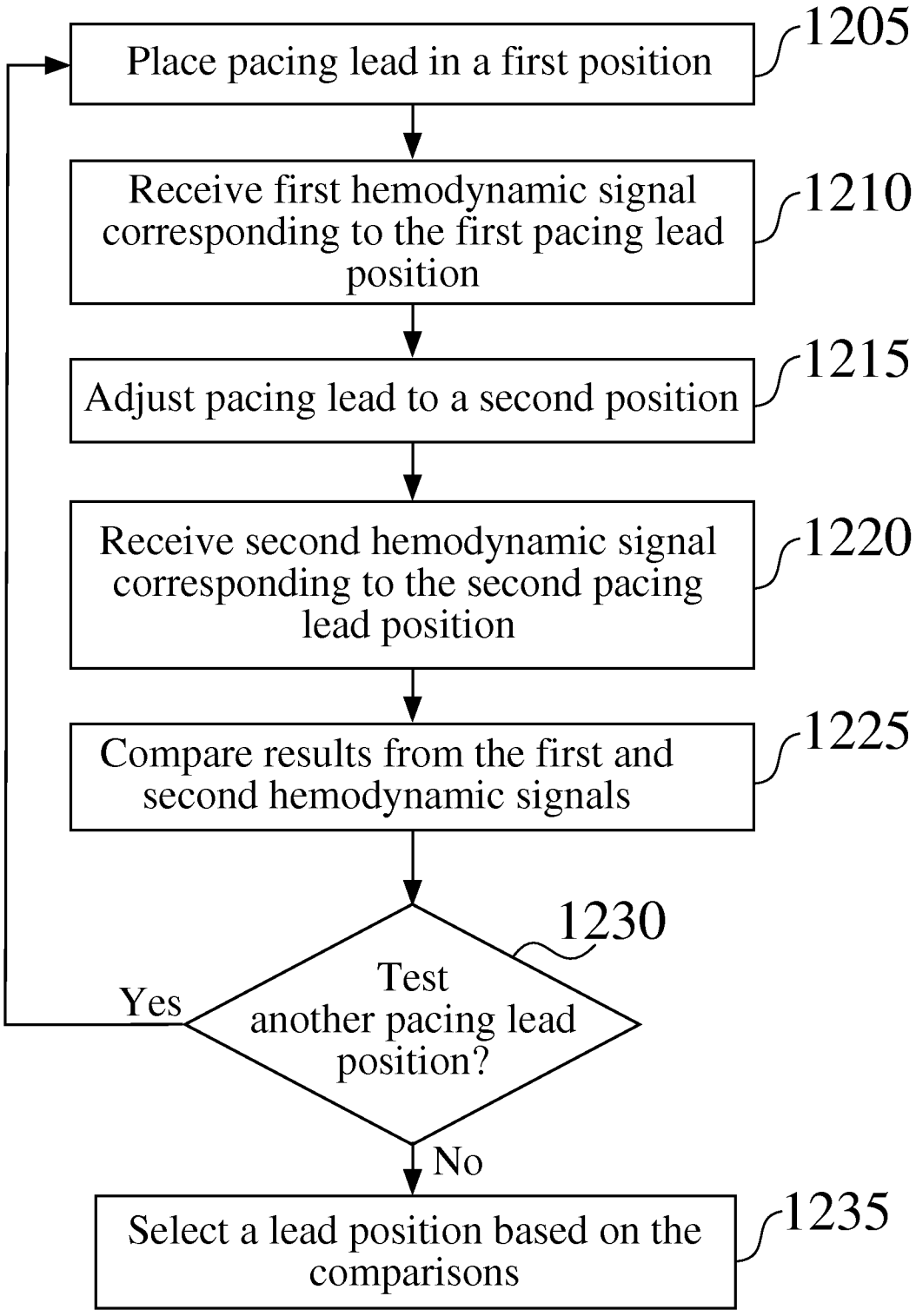
Place pacing lead in a first position
1205
Receive first hemodynamic signal corresponding to the first pacing lead position
1210
Adjust pacing lead to a second position
1215
Receive second hemodynamic signal corresponding to the second pacing lead position
1220
Compare results from the first and second hemodynamic signals
1225
Test another pacing lead position?
1230
Yes
No
Select a lead position based on the comparisons
1235

Fig. 12B

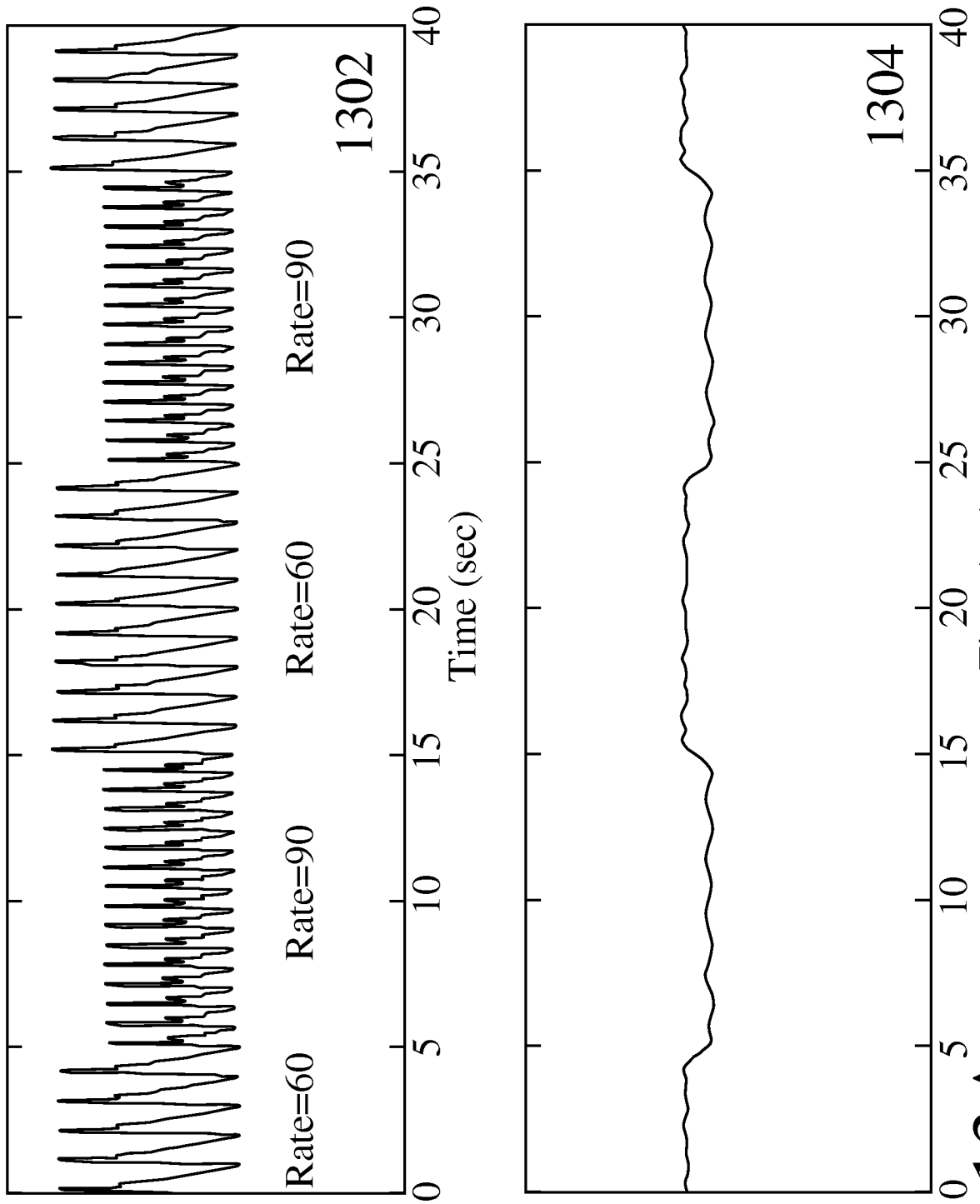
Hemodynamic Response
Rate=60
Rate=90
Rate=60
Rate=90
1302
0
5
10
15
20
25
30
35
40
Time (sec)
Hemodynamic Response
1304
0
5
10
15
20
25
30
35
40
Time (sec)

Fig. 13A

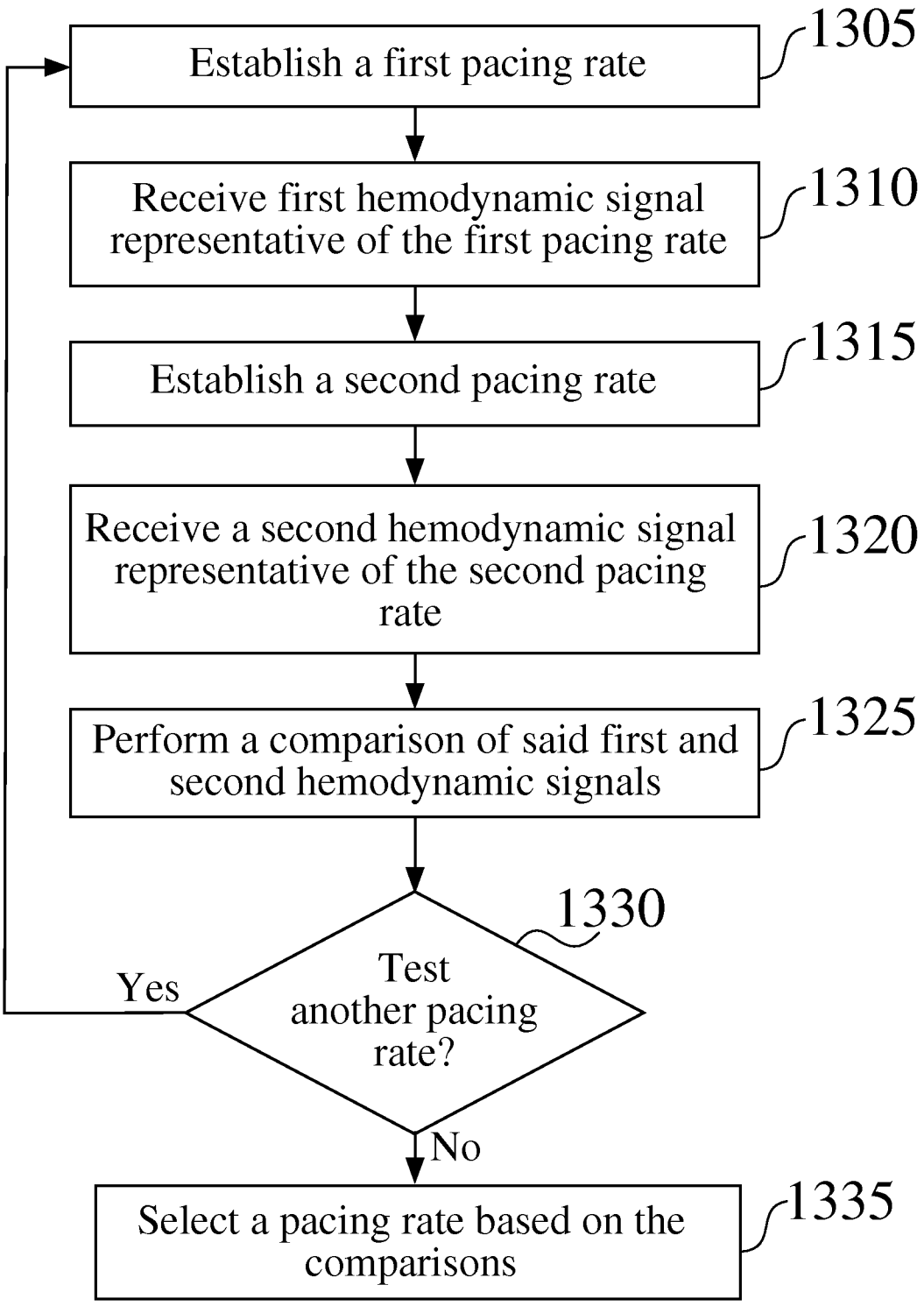
Establish a first pacing rate
1305
Receive first hemodynamic signal representative of the first pacing rate
1310
Establish a second pacing rate
1315
Receive a second hemodynamic signal representative of the second pacing rate
1320
Perform a comparison of said first and second hemodynamic signals
1325
Test another pacing rate?
1330
Yes
No
Select a pacing rate based on the comparisons
1335

Fig. 13B